WATER FACT SHEET

U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR

NATIONAL RESEARCH PROGRAM: GROUND-WATER PERSPECTIVE

BACKGROUND

Improved water-well technology and low-cost electricity over the last few decades have made it possible to develop ground-water supplies for irrigation, industrial, and public water-supply use. The subsequent removal of water from aquifers has in some areas caused significant environmental problems, such as decreased streamflow, lowered lake levels, dried-up springs, seawater intrusion in coastal areas, and land subsidence that has caused damage to buildings, canals, and pipelines. Concurrently, reports of ground-water contamination indicate that understanding chemical and biological changes in water is as important as understanding the occurrence and movement of subsurface water in order to effectively develop, protect, and manage ground-water resources. In response to a growing interest in ground water nationwide, the U.S. Geological Survey (USGS) established a Federal program of water-resources research, including ground-water hydrology, in the late 1950's.

WATER RESOURCES NATIONAL RESEARCH PROGRAM

The overall objective of the National Research Program (NRP) of the USGS is to increase understanding of the factors that affect the quantity and quality of surface- and ground-water resources. The centers for this unique hydrogeologic research program are located in Reston, Virginia; Denver, Colorado; and Menlo Park, California.

The formal training of NRP scientists includes the disciplines and many subdisciplines of geology, hydrology, geochemistry, chemistry, biology, engineering, and geophysics. These scientists conduct research within the NRP, with other scientists of the USGS, and in cooperation with other American and foreign scientists. Results of the research findings are made available to the public through numerous seminars, workshops, and short courses; through symposia at national and international professional societies; by publication in national and international scientific journals; and in publications of the USGS.

PURPOSE

The fundamental responsibility and goal of the program is to support scientists of the USGS in evaluating the Nation's water resources. The research also provides a sound scientific basis for water-resources management, regulatory responsibilities, and natural-resources conservation programs of other Federal, State, and local agencies. Research conducted by scientists of the USGS, academia, and other organizations has developed the basic principles, concepts, and techniques that allow prediction and resolution of many serious ground-water problems that face the Nation. Such research is directed toward determining the amount of water and constituents that will move along the various ground-water flowpaths, how fast the constituents will move, what the concentration of constituents will be at different points along the flowpath, and what effect the dissolved constituents will have on the chemistry of the water in wells and in lakes and streams where the ground water discharges.

ACTIVITIES

Computer simulations (models) have been developed that represent the flow of ground water for any particular area. By simulation of the addition or withdrawal of water, the models can be used to predict the future flowpath of water. Such information is of great benefit to water-resources managers and planners in agencies that have the responsibility for providing satisfactory water supplies to meet increased population demands, and for implementing zoning restrictions for the most beneficial use of land. Comparable computer models that use principles from thermodynamics have been developed to identify which chemical reactions will occur along the flowpath, how fast the reactions will take place, and what the concentrations of contaminants or other dissolved constituents will be in the future.

Some NRP scientists study chemical reactions that are controlled by bacteria and other microorganisms that grow in the environment near the land surface and down to depths of several hundred feet. Others work on

determining what the ground-water flowpath would be with fluids of a density different from freshwater, such as in the coastal aquifers where freshwater mixes with seawater, or in contaminated aquifers where the contaminant may float on the freshwater or sink through the freshwater and move at velocities different from that of freshwater. Some scientists undertake investigations to determine how ground water affects the Earth's surface; they study not only subsidence or ground collapse caused by ground-water withdrawal, but also how the pressure exerted by water on the rocks affects earthquakes, and how ground water causes the formation of caves and lakes and other land-surface features.

The reliability of computer simulations depends on the scientist's knowledge of the distribution of the pores and other openings in the rocks and the composition (mineralogy) of the rocks through which the water flows. Owing to the complexity of ground-water flow and of the chemical reactions that occur in the subsurface, single projects seldom can obtain all of the information required to develop mathematical models. Therefore, the work from many individual projects, both independently and together, focuses on various aspects of the overall problem. Three examples of ground-water research activities of the USGS National Research Program are discussed in the following sections.

Topographically Influenced Air Circulation at Yucca Mountain, Nevada

The circulation of air and water as a vapor through fractures in a thick unsaturated zone—that is, the zone above the water table where the pores in rocks are not completely filled with water—probably is controlled by seasonal air temperature differences and topographic relief of the rock formation. Such a fractured unsaturated zone at Yucca Mountain in Nevada is being considered for a high-level radioactive-waste repository. At Yucca Mountain, this air circulation process may dry the rocks and, therefore, reduce the potential for deeply percolating water to transport radionuclides that are leached from the wastes; however, gaseous radionuclides may be transported to the atmosphere more quickly. Thus, improved understanding of this air circulation process and of flow in the unsaturated zone is extremely important in the evaluation of Yucca Mountain and other potential sites for the long-term storage of radioactive and hazardous wastes.

Availability of Freshwater, Hawaiian Islands

Many islands are composed either of limestones or volcanic rock. Openings in these types of rocks consist primarily of fractures or flow tubes. Sources of freshwater are very important to island economies. Research on the island of Oahu in Hawaii is aimed at developing advanced methods of predicting the availability of freshwater in volcanic rocks. The research includes study of recent volcanic activity on the island of Hawaii to understand the older volcanics of Oahu, the development and use of instruments that can be lowered into a well (borehole geophysics) to determine the size, distribution and extent of openings in the rocks, and the development of mathematical models for advanced computer simulations of the ground-water flow system in these rocks. A better understanding of the ground-water system on the island of Oahu will provide the basis for local government to manage this system for the greatest benefit of the growing urban areas, which are competing with agricultural requirements for freshwater. In addition, the basic understanding of a system with large-size pores will be useful to water-resources officials of the other Hawaiian islands, and in other areas of the country and world having similar bedrock.

Creosote Contamination, Pensacola, Florida

Discharge of affluent wastes that contain creosote and other organic compounds into surface impoundments at a wood-treatment facility has contaminated a sand and gravel aquifer near Pensacola, Florida. Results of detailed geochemical, biological, and hydrological research conducted at the site are contributing to the understanding of some processes that affect the movement and fate of creosote in the subsurface. Some of the contaminants are degraded by microbial processes, some are retained on aquifer materials, and others are unaltered during transport in ground water. Research findings from this study can be applied to other sites to help determine the movement and fate of similar types of contaminants.

For more information on technical reports and data related to ground-water research, contact:

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